Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	)	
	)	
Revision of Part 15 of the Commission's	)	**Docket No. 98-153**
Rules Regarding Ultra-Wideband	)	
Transmission Systems	)	

To: The Commission

REPLY COMMENTS OF ARRL, THE NATIONAL ASSOCIATION FOR AMATEUR RADIO

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SUMMARY

ARRL, The National Association for Amateur Radio ("ARRL"), submits its reply comments in response to the *Notice of Proposed Rule Making*, FCC 00-163, 65 Fed. Reg. 37332, released May 11, 2000 (the Notice). The Notice proposes to permit operation of ultra-wideband radio systems (UWB) on an unlicensed basis under Part 15 of the Commission's Rules in certain configurations, to be determined.

The record in this proceeding, though extensive given the large number of voluminous comments filed in response to the Notice, still lacks conclusive test results from ongoing testing efforts from various sources. In its comments, ARRL noted that the Commission promised an ample opportunity to review and analyze test results of UWB interference potential prior to adopting final rules governing these systems, and urged that no action be taken in this proceeding until that opportunity was afforded. There has not been afforded interested parties an opportunity to review the test data and associated standards to be proposed in light of the test data. That data is due in this proceeding October 30, 2000. It is difficult to understand, therefore, why the Commission chose to extend the reply comment period at Motorola's request, but only until October 27, 2000, only three days before the test data was to have been filed. ARRL urges the Commission to afford a reasonable period for review of subsequently submitted test data and a further comment period to address such. It should also be noted that the ITU Radiocommunication Sector has just begun studies of UWB and has not as yet had any substantive input from administrations. Therefore, it remains ARRL's view that this matter is entirely premature as a rulemaking proceeding.

ARRL, like the Department of Defense in this proceeding, urges the Commission to await the outcome of its tests concerning the interference potential of UWB devices to the variety of amateur receivers prior to making any decision concerning proper UWB operational and technical requirements. In any case, however, ARRL urges most strongly that any UWB devices be required to operate above 2450 MHz, to avoid interference to sensitive receivers, especially those used for amateur satellite reception.

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	)	
	)	
Revision of Part 15 of the Commission's Rules Regarding Ultra-Wideband Transmission Systems	)	**Docket No. 98-153**

To: The Commission

REPLY COMMENTS OF ARRL, THE NATIONAL ASSOCIATION FOR AMATEUR RADIO

ARRL, The National Association for Amateur Radio (also known as the American Radio Relay League, Incorporated) (hereinafter "ARRL"), by counsel and pursuant to the *Notice of Proposed Rule Making*, FCC 00-163, 65 Fed. Reg. 37332, released May 11, 2000 (the Notice), hereby respectfully submits its reply comments in the captioned proceeding. These comments are timely filed[1]. The Notice proposes to permit operation of ultra-wideband radio systems (UWB) on an unlicensed basis under Part 15 of the Commission's Rules under certain circumstances. For its reply comments, ARRL states as follows:

1. ARRL notes that the record in this proceeding, though extensive given the large number of voluminous comments filed in response to the Notice, still lacks conclusive test results from ongoing testing efforts from various sources. In its comments, ARRL noted that the Commission promised an ample opportunity to review and analyze test results of UWB interference potential prior to adopting final rules governing these systems, and urged that no

[1] The Reply Comment date was extended by Order,DA 00-2255, released October 4, 2000.

action be taken in this proceeding until that opportunity was afforded. Given that, ARRL favored the request of Motorola to extend the reply comment period in this proceeding to November 21, 2000, which would have permitted the parties an opportunity to review the test data and associated standards to be proposed in light of the test data. That data is due in this proceeding October 30, 2000. It is difficult to understand, therefore, why the Commission chose to extend the reply comment period at Motorola's request, but only until October 27, 2000, only three days before the test data was to have been filed. ARRL urges the Commission to afford a reasonable period for review of subsequently submitted test data and a further comment period to address such. It should also be noted that the ITU Radiocommunication Sector has just begun studies of UWB and has not as yet had any substantive input from administrations.

2. For its part, ARRL has recently arranged for testing of the interference potential of UWB devices to typical amateur radio station configurations. ARRL technical representatives met with the University of Southern California UWB laboratory, and has provided the laboratory with amateur radio equipment for testing. Specifically, ARRL sent 1.2 GHz multi-mode receiving equipment to the laboratory staff, who have agreed to work with local ARRL technical representatives in the field testing of UWB interference potential. This testing is ongoing, and it is anticipated that the test results will be completed, assembled and filed with the Commission in this proceeding before the end of the calendar year. ARRL is also in contact with other parties interested in UWB technology and anticipates participating in additional tests. ARRL is convinced that the studies conducted to date cannot accurately reflect the diversity of the Amateur Radio Service, and it urges that no sweeping rules changes be made until all available studies and data are available and analyzed. Preliminary data from a few of the other studies were offered as

comments or in *ex parte* presentations, the results of which are widely divergent. Some conclude that there is little potential for interference to other users, while other studies conclude just the opposite. ARRL does not believe that it is possible for anyone to determine the accuracy of the conclusions until all the test data are available and the differing conclusions refereed.

3. ARRL remains concerned that the Notice in this proceeding proposed no actual rules, and hence was effectively nothing more than a further notice of inquiry. The comments filed in response to the Notice do not facilitate the adoption of firm rules at this juncture, but some generalized observations are possible from a review of them.

4. ARRL's review of the record in this proceeding to date continues to support the conclusion that UWB technology has potentially beneficial applications which should be accommodated, subject to appropriate interference avoidance regulations. It is also apparent that the interference potential of one class of UWB applications may be significantly less than another class. ARRL was impressed with the comments of the U.S. GPS Industry Council (GPSIC) which urged that the Commission distinguish between two classes of UWB devices. The first class would include Ground Penetrating Radars (GPR) and through-wall imaging devices (WID) only. The second would include all other UWB devices, including UWB radars other than GPR and WID, and all UWB communications devices. The classifications make sense here, where the Commission obviously wants to proceed as soon as possible with rules permitting UWB technology, but where the interference potential of such devices is yet to be determined. The GPS Council argues persuasively that rules governing the second class of devices should be deferred until a later proceeding. The first class of devices uses single emitters with low duty cycles with predictable deployment environments and extremely short range, while the second

uses either networks of devices (in the case of communications UWB devices) or applications which might incorporate extensive deployment of single emitters in congested environments (such as automotive anti-collision radars) with potentially greater interference parameters. ARRL would urge, therefore, that the Commission consider authorization of UWB devices in steps, by class, given the extensive variety of applications and the widely variable interference potential.

5. ARRL also notes the consistency between the position of the GPSIC and ARRL relative to frequency limitations. GPSIC would limit the deployment of UWB devices to frequencies above 3 GHz. ARRL's comments urged that UWB devices be limited to bands above 2.5 GHz, so as to avoid any interaction with Amateur and Amateur-Satellite systems operating in the 2400-2450 MHz band. For the same reason that GPSIC is concerned about interference to handheld GPS receivers, ARRL is concerned with interference from UWB devices to sensitive satellite receivers in use by radio amateurs, especially in the 2400-2402 MHz range. Given the increasing presence of Part 15 devices in the 2400-2483.5 MHz band, it would make sense to limit UWB devices to the bands above, at least, 2.5 GHz, or as GPSIC urges, 3 GHz. GPSIC's position is supported as well by the Department of Defense (DOD). As noted in the Memorandum to the Chairman of the Interdepartment Radio Advisory Committee (IRAC) of the National Telecommunications and Information Administration (NTIA) filed in this proceeding October 6, 2000, at page 2:

> ...(R)estrictions (should) be placed on UWB devices operating below 2.29 GHz to the extent identified by the results of ongoing tests and analyses to ensure protection of sensitive earth station receptions in the 2200-2290 MHz band and to protect reception of GPS navigation signals in the 960-1215, 1215-1300 and 1559-1610 MHz bands; and ...the Commission (should) adopt rules to ensure that the levels of UWB spurious and out-of-band emissions in bands below 2.29 GHz resulting from UWB devices operating above 2.29 GHz are kept below the levels identified as problematic as a result of testing and associated analyses.

Ultimately, at page 9 of that Memorandum, DOD concludes for its own purposes that since critical downlink telemetry and tracking data from DOD satellites, including GPS, is received by a network of sensitive earth station receivers that operate in the 2200-2290 MHz band, DOD is particularly concerned about the effects of unlicensed UWB operations below 2290 MHz to ensure protection of the sensitive earth station receptions. Likewise, ARRL is very much concerned about the Amateur Satellite Service, which has immediate and future needs for the 2400-2402 MHz band, and future plans for the segment immediately above 2402 MHz. For this reason, ARRL again urges that no UWB operation be permitted in the bands below 2.5 GHz.

6. Indeed, most of the studies that have been submitted in the record to date have primarily dealt with GPS receivers. While useful in that context, ARRL would note that GPS uses spread-spectrum techniques that offer significant immunity to interference. The Amateur Service, however, uses a wide range of modulation techniques that are often received at the ambient noise levels present at an amateur station. The high antenna gain systems in use by some amateur stations significantly extend the interference ranges reported for GPS or other types of commercial receivers. None of the studies underway have been specifically targeted to weak-signal, high-antenna-gain receiving installations. The Motorola comments address "generic" receiver degradation, and the techniques offered by Motorola, if adjusted for actual ambient noise levels, show significant promise.

7. ARRL continues to believe that UWB devices should be regulated under Part 15 as unlicensed devices, given the difficulty of classification into a particular radio service's allocations, and the means by which the devices are to be deployed. This is especially true with

respect to GPR and WID devices, which have limited interference potential, use relatively low power and extremely short operating ranges. However, as with more typical Part 15 devices, the interference potential should be regulated by means of carefully calculated peak, average and power spectral density based on empirical analysis and testing. As the DOD put it, at page 3 of the Memorandum submitted in this proceeding by NTIA:

> We believe that there is insufficient evidence, based mainly on the lack of mass-marketed UWB devices, to draw [the] conclusion at this time [that UWB devices appear to be able to operate on spectrum already occupied by existing radio services without causing interference]. The analyses and measurements underway and planned to address specific interference issues with systems in restricted bands will provide this evidence and may or may not support this conclusion.

Furthermore, the DOD comments stated that no interference mitigation techniques, such as notch filters, should be ruled out pending the results of the ongoing tests. At page 5 of its Memorandum, DOD stated:

> The Commission indicated that several comments opposed the use of notch filters to reduce harmful interference to existing radio operations in the restricted frequency bands, TV broadcast bands, amateur radio frequency bands, and others. The DoD believes this option should not be ruled out until measurement results demonstrate that no unacceptable interference will be caused to GPS reception and other critical services.
>
> *****
>
> We agree with the statement that critical systems in the restricted bands must be "protected against interference". To understand the technical and operational conditions under which UWB devices must be used to ensure this protection, credible analyses and measurements are required for the critical systems that must operate in these restricted bands. Historical anecdotes and comparisons with unintentional radiators are insufficient evidence upon which to base national policy.

ARRL shares DOD's concerns about interference avoidance provisions, and the means of determining the proper operating parameters for different UWB devices. With respect to notch filters for certain bands, the assumption should not be made that it is infeasible to filter UWB

devices to preclude operation on the restricted bands, or other bands in which interference to sensitive receivers may occur.

8. As ARRL's comments stated, the Commission should not make assumptions concerning UWB interference potential. Instead, it should insist on some technical test results which would allow an objective determination of interference potential, especially with respect to the sensitive and safety-related services operating in the restricted bands. Among the assumptions contained in the Notice on this subject are two that the Commission has relied on in other Part 15 proceedings: (1) that UWB devices can generally operate in the spectrum above approximately 2 GHz without causing harmful interference due to high propagation losses; and (2) that use of directional antennas decreases the likelihood of interference coupling conditions. These assumptions cannot reasonably be made in this proceeding in particular. First, propagation path loss is only one factor in determining the potential for interference and does not, without more, determine interference potential. Second, while directional antennas indeed decrease the likelihood of interference coupling conditions, they greatly exacerbate interference received in the instances where coupling takes place. In this situation, an accurate determination of the aggregate number of deployed devices in a given environment is critical, and this information cannot be gleaned from the record in this case thus far. If UWB devices, especially communications devices, are to be mass-marketed to consumers and to businesses on an unlicensed basis, the issues of notch filtering, directional antennas, and accurate predictions about the market for such devices, all become rather critical.

9. ARRL disagrees with those commenters who have stated that a single UWB emitter would be expected to predominate in creating noise to a particular receiver installation. While

this may be true in those cases where the interference potential extends for tens of meters, Motorola's comments include a graph (Figure 2 on page 18) that demonstrates that the interference potential to sensitive receivers with high-gain antennas could extend for hundreds of meters. Their Monte Carlo analysis demonstrates that multiple UWB sources affecting such a receiver would be the norm, not the exception. This conclusion was separately reached by Sprint PCS, which stated, at page 9 of its October 2, 2000 Supplemental Comments, as follows:

> It is important that the issue of impact from multiple nearby UWB transmitters, which is real and unquestionable given simultaneous noise-like transmission, not be confused with the issue of cumulative impact of millions of devices, a more complex issue that has been the subject of much research and debate. Common sense and elementary RF engineering principles, together with the very nature of CDMA technology, suggest that if one UWB device causes harmful noise-like interference at three meters, a second or third device located at 3.1 meters will cause additive harmful interference if transmitting simultaneously. By analogy, a pedestrian who happens to be very near to a street lamp will mostly be illuminated by that lamp, but if the pedestrian is somewhere between two lamps, then both sources contribute. The same holds with UWB interference impact...

10. It is also notable that many of the UWB studies underway assume Gaussian distribution of noise-like interference. ARRL has used this technique in some of its own calculations. However, though this would apply to some modulated or dithered UWB signals, other UWB signals would consist of discrete modulation sidebands, spaced at the pulse-repetition rate. These individual sidebands would be at a higher level than broadband noise spread across the entire spectrum. The effect of such signals should also be considered in some of the field testing that is underway.

11. There is a wide range of what is being considered as "Ultra Wideband" in the comments. ARRL supports the position that systems with a fractional bandwidth of less than 25% of the operating frequency should not be considered as UWB. It should be possible for

manufacturers to design such relatively narrow bandwidth systems within the constraints of the present rules. Several manufacturers have done so. ARRL also notes that there is a wide range of uses and modulation techniques being proposed as in the UWB category. Much of the testing underway does not take the many possible variations into account. Therefore, the results cannot necessarily be extrapolated to address all of the proposed systems. The diversity of the proposed systems is matched by an equal diversity in the types of receiving equipment used across this wide swath of spectrum, with uses ranging from sensitive amateur reception to critical aeronautical and public-service systems. The testing now underway should not only be completed, commented upon and analyzed; it should be reviewed for comprehensiveness as well. Sufficient data should be gathered to address the diversity of UWB and of the sundry incumbent licensees and users of the spectrum subject to UWB operation. Delphi Automotive commented that the Commission should accommodate in its rules a variety of alternative, non-impulse waveforms, some of which transmit far less peak power and average power than devices which might be permitted in this proceeding pursuant to the Notice. Delphi urges that all modulation schemes be permitted, provided that peak, average and power spectral density limits are met. That, of course, is the trick here: determining the proper peak, average and power spectral density levels. ARRL has no problem with the Commission permitting pulse and non-impulse modulation schemes, but the determination of the proper power spectral density limits referenced to one megahertz cannot be done on the present record.

12. In summary, ARRL agrees with the ultimate conclusions of the DOD (at pages 16 and 17 of its Memorandum), with which the Amateur Service shares much of its own frequency allocations:

> The DoD urges the FCC to base any decisions on acceptable emission levels of UWB devices on credible analyses and measurements, and not on arguments emphasizing the lack of historical interference from Part 15 unintentional radiators or on the past use of the limited number of currently available UWB devices. As demonstrated in early analysis results referenced in the comments above, there is potential for interference within certain restricted bands under certain circumstances. As the FCC is aware, past and present uses of Part 15 devices or UWB-type devices does not represent the potential future scenarios that may occur. These future scenarios must be evaluated for interference potential and the likelihood of them occurring assessed. The DoD believes that the determination of potential impact of UWB devices to existing systems should be based on measurement results supplemented, when needed, by acceptable interference analysis procedures. In particular, we urge the Commission to allow sufficient time for both Government and industry to complete on-going and planned UWB-to-GPS interference test programs. Many of these analyses and measurements are ongoing and the DoD urges the FCC to await final decision on the use of UWB devices on the outcome of these activities.

ARRL likewise urges the Commission to await the outcome of its tests concerning the interference potential of UWB devices to the variety of amateur receivers prior to making any decision concerning proper UWB operational and technical requirements. In any case, however, ARRL urges most strongly that any UWB devices be required to operate above 2450 MHz, to avoid interference to sensitive receivers, especially those used for amateur satellite reception.

Therefore, the foregoing considered, ARRL, the National Association for Amateur Radio, respectfully requests that the Commission not proceed to adopt final rules for Ultra-Wideband

devices based on the instant notice and the comments thereon. Instead, the Commission should proceed in accordance with the recommendations contained herein.

Respectfully submitted,

ARRL, THE NATIONAL ASSOCIATION FOR AMATEUR RADIO

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October 26, 2000

CERTIFICATE OF SERVICE

I, Christopher D. Imlay, do hereby certify under penalty of perjury that I caused to be served, this 27th day of October, 2000, via United States Mail, postage prepaid, a copy of the "REPLY COMMENTS OF ARRL, THE NATIONAL ASSOCIATION FOR AMATEUR RADIO" on the following:

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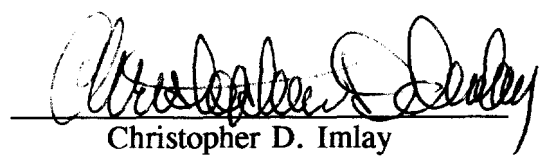

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